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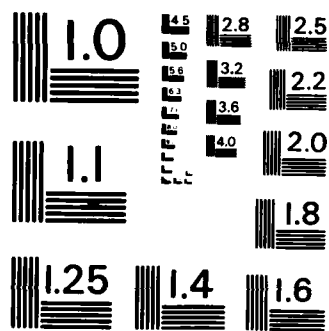
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Bethesda, Maryland 20084

MULTIPLE ACCOUNT IMPLEMENTATION
FOR VAX/VMS

by

Gary C. Volo

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Computation,Mathematics and Logistics Department
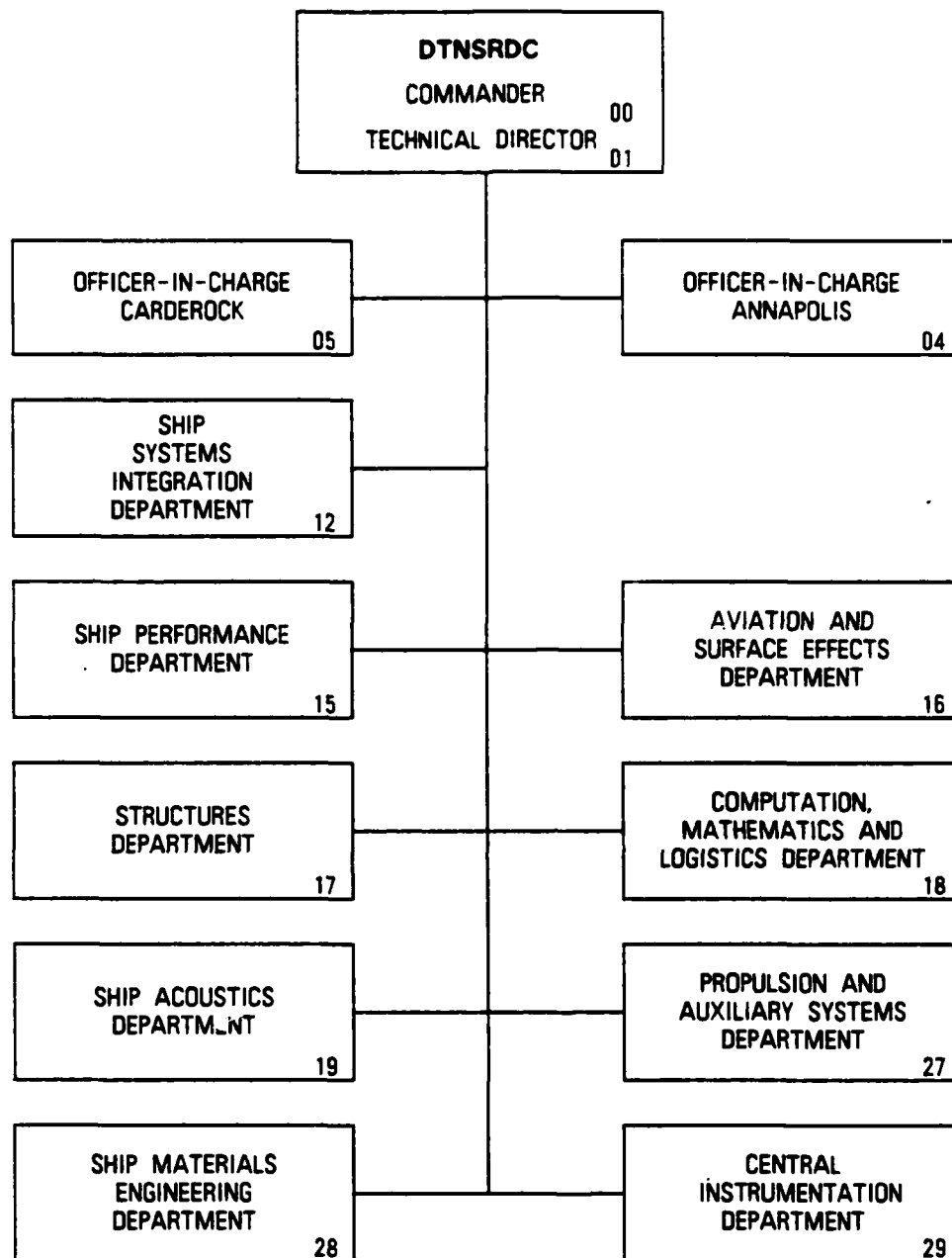Departmental Report

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report provides a basic overview of design philosophies and implementations of the DTNSRDC Computer Center's Accounting Scheme (CAS) for the Scientific and Engineering (S&E) VAX Systems. These systems are running the VAX/VMS Operating System - Version 4.2 (VMS), and are maintained by Code 189.

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Abstract

This report provides a basic overview of design philosophies
and implementations of the DTNSRDC Computer Center's
Accounting Scheme (CAS) for the Scientific and Engineering
(S&E) VAX Systems. These systems are running the VAX/VMS
Operating System - Version 4.2 (VMS), and are maintained by
Code 189.

Administrative Information

The work described in this report was performed in the Systems
Software Group (1892.3) of the Computation, Mathematics and
Logistics Department, David W. Taylor Naval Ship Research and
Development Center under sponsorship of the DTNSRDC Computer
Center (189).

Introduction

VMS, the supported operating system for Digital's VAX series
of super mini-computers, provides resource accounting
information to the system management personnel which can be
used to generate reports summarizing the resource utilization
of the VAX Systems. These reports include summaries of CPU
time, Connect time, I/O time, tape mounts, pages printed and
disk space utilization. VMS assumes that each user will be
authorized for only one, eight-character account number. 189
has specific needs in an accounting package which are not
standard features under VMS. Among these needs are the
ability to allow users to charge to specific job order numbers
for specific projects, provide accounting analysis across the
VAXcluster, and to provide a method of interfacing VMS' eight
character ACCOUNT field with a ten character job order number.

This paper details the required accounting enhancements for
the Center, broken down into five sections: UPDATE, LOGIN,
Advantages and Disadvantages of CAS vs. VMS, ANALYZE and
Future Enhancements. The UPDATE section will include a USER'S
GUIDE to the UPDATE procedure for authorizing users to CAS and
VMS. The LOGIN section deals with the inner workings of CAS,
and how it taylors the user environment for multiple job
order- numbered users. The ANALYZE section describes the
group of routines which use the VMS Accounting Utility to
extract resource accounting information that can be processed
by local routines to provide Code 189.3 a resource summary
with appropriate charges. In addition, the other two sections
deal with the advantages and disadvantages of CAS vs. VMS,
and some future enhancements to CAS. Please note that any
routines discussed in this paper are under the cognizance of
the VAXcluster System Manager and are not available for
general use.

1   UPDATE

Frequently Used Terms/ Abbreviations

Abbreviations:

1.   CAS - Computer Center Accounting Scheme

2.   UAF - User Authorization File

3.   UIC - User Identification Code

4.   ATF - Accounting Transfer File

5.   CAF - Computer Center Authorization File

6.   PAF - Project Accounting File

7.   UDF - User/ Device File

Definitions:

1.   UAF - file which VMS uses to make the system
     resources available to users. Holds UIC, ACCOUNT,
     Default Directory, etc.

2.   UIC - a code which is written to data structures
     indicating ownership and is used to determine
     access to files and devices.

3.   CAF - file which CAS uses to make the system
     resources accountable to users. Holds UICs,
     ACCOUNTS, Default Directories, Account Numbers,
     User Initials, etc.

4.   PAF - file which CAS uses to make the system
     resources accountable at the project/(account)
     level. Holds job order numbers, and the number of
     users allowed to charge to each job order number.

5.   UDF - file which CAS uses to determine which device
     to add a new user to. Holds device names, number
     of accounts currently residing on each device, as
     well as which device has the most users.

6. Account Number - a field in the VMS process data structures

7. Job Order Number - Defined by DTNSRDC Financial Management Department

8. ACCOUNT - general term for access to a computer system. (ie. USERNAME, PASSWORD, Job Order Number)

9. AUTHORIZE - the addition of a user to the CAF, PAF, UDF and UAF

10. UPDATE - local routine to authorize users and guarantee that the data in the VMS and CAS accounting files is consistent

FUNDAMENTALS:

1. UICs - [Group, Member]

   Group - each user forms a unique group (default)

   Member - each user is a unique member within the group

2. USER - forms a unique group regardless of how many job order numbers. (default)

3. USER INITIALS - 4 characters which uniquely identify a user from all other users. These initials are the same for each user on all of the computers managed by the Computer Center.

4. USERNAME - same as the User Initials. (default) However, USER INITIALS appended with 1-8 characters are allowed as special cases for system maintenance only.

5. FULLNAME - a 1-31 character identifier which uniquely identifies each USER. Typically the USER's surname.

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6. ACCOUNT NUMBER

   - each user may charge to one or more job order numbers

   - this associates charges to job order number

   - this field is 8 characters in length and appears in the ACCOUNT field in the USER's process data structures. (The 10 character job order number is packed into this field)

7. ACTIVE/ INACTIVE

   - either a user, or one of a user's job order numbers may be made inactive due to depleted funds, or a number of other reasons.

   - when made inactive, users are not allowed to charge any more resources against the account or job order numbers which have been disabled.

   - a user may request that an account be made inactive while the user is on travel, etc., as an added security feature.

UPDATE STARTUP AND MAIN MENU DESCRIPTION

1. To execute UPDATE, enter @UPDATE

2. Once this is entered, UPDATE produces the Main Menu
    and prompts for an option:

    1. ADD   - add a new user to the system

    2. LIST   - produce a listing of system users

    3. DISABLE - disable a user

    4. ENABLE   - enable a user

    5. REMOVE   - remove a user from the system

    6. MODIFY   - modify charge codes

    7. HELP   - produce details about the commands

    8. STOP   - terminate this program

FULL EXPLANATION OF OPTIONS:

A. ADD:

1. This option adds elements to the CAS files: CAF, PAF, UDF, and the VMS System User Authorization File.

2. All elements added (USERNAME, FULLNAME, ACCOUNT, etc.) are added with a default of ACTIVE.

3. The ADD module only prompts for the following information:

   a. User Initials

   b. FULLNAME (if new user)

   c. ACCOUNT Number

   d. USERNAME

4. The ADD module automatically assigns the following:

   a. UIC [Group, Member]

   b. Initial password

   c. Default Directory

   d. Default Device

   e. Default Protections

   f. Privileges

   g. ACTIVE flag

5. If ADD detects an error it outputs an informative message, and saves temporary files created for this operation for checking

6. A success message is displayed that indicates the addition of the user to the following:

    a. CAF

    b. PAF

    c. UAF

    d. UDF

B. LIST:

    1. This option generates a listing of both the CAF and PAF which can also be displayed at the terminal

C. DISABLE:

    1. This option disallows a user to login. This feature is handy when a user goes on extended leave.

D. ENABLE:

    1. This option allows a user who has been DISABLED to login.

E. REMOVE:

    1. This option removes a user from the system. The user no longer has access to the system, and all files will be deleted once they have been backed up to tape.

    2. The actual deletion of the user is completed manually.

F. MODIFY:

    1. This option allows the modification of one or more of the job order numbers the user has been authorized for. There are four modification operations:

        a. CHANGE: CHANGE replaces all occurrences of the old account number with the new account number. This option is especially useful

at the end of a fiscal year when all of the account numbers are changed.

b. DELETE: This option deletes a job order number from a user. Files will be backed up to tape at the next opportunity. Deletion can occur by specifying an individual user or all users authorized for that job order number.

c. ACTIVATE: This re-enables a job order number by specifying a single user, or all users authorized for that job order number. Users are then allowed to charge system resources to the job order number which has been reactivated.

d. INACTIVATE: This works just the opposite of the way ACTIVATE works. Users are disallowed to charge system resources to the INACTIVATED job order number until it has been re-activated.

G. HELP: This option produces a full description of the commands in the main menu. After this information has been output, the program returns to the main menu and prompts for the desired option.

H. STOP: This option allows the user to terminate the UPDATE procedure.

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1.5 UPDATE USER'S GUIDE

(The following are examples of the interfaces between
UPDATE and the individual executing. For purposes of
clarity in this example, when UPDATE expects a response,
a colon will appear at the end of the last line output by
UPDATE, and sample responses will be represented by <Z>,
where Z is the input entered; <CR> indicates striking the
return key without entering anything beforehand. In
addition, x indicates a variable numeric.)

A. ADD

The four most popular occurrences of ADDing a user
follow –

1. ADDing a new user, ABCD, to an existing account,
    taking the default device, UIC Group, and UIC
    Member chosen by ADD.

    ACCOUNT NUMBER: <0123456789>
    USER INITIALS : <ABCD>
    * new user *
    ENTER FULLNAME: <John Doe>
    ENTER USERNAME: <ABCD>
    Enter 1,2,3<CR> : <CR>
    .. next device is ... USERDISKx
    Next GROUP is [000400]. Hit (N) to enter another: <CR>
    Default MEMBER is [000400]. Hit (N) to change: <CR>
    (success or failure message)
    WOULD YOU LIKE TO ADD ANOTHER? :

2. ADDing another account to an existing user and an
    existing account –

    ACCOUNT NUMBER: <0123456789>
    USER INITIALS : <John Doe>
    WOULD YOU LIKE TO ADD ANOTHER? :

3. ADDing an account to an existing user where the
    account is new –

    ACCOUNT NUMBER: <01234567890>
    USER INITIALS: <ABCD>
    * new account - confirm (Y) * : <CR>
    WOULD YOU LIKE TO ADD ANOTHER? :

4. ADDing a new user, ABCD, to an account which does
not exist and taking the default Device, UIC
Group and UIC Member chosen by ADD.

```
ACCOUNT NUMBER: <0123456789>
* new account - confirm (Y) * : <CR>
USER INITIALS: <ABCD>
* new user *
ENTER FULLNAME: <John Doe>
ENTER USERNAME: <ABCD>
Enter 1,2,3<CR> : 2
.. next device is ... USERDISK2
Next GROUP is [000500]. Hit (N) to enter another:
<CR>
Default MEMBER is [000500]. Hit (N) to change:
<CR>
(success or failure message)
WOULD YOU LIKE TO ADD ANOTHER? :
```

B. LIST:

```
Hit Y to display CAF at the terminal :   <Y>
Hit Y to display PAF at the terminal :   <CR>
```

C. DISABLE:

```
Enter INITIALS:  <ABCD>
ABCD has been DISABLED in the UAF
Would you like to DISABLE another?  :
```

D. ENABLE:

```
Enter INITIALS:  <ABCD>
ABCD has been ENABLED in the UAF
Would you like to ENABLE another?  :
```

E. REMOVE:

```
Enter INITIALS:  <ABCD>
ABCD has been DISABLED in the UAF pending deletion
Would you like to REMOVE another?  :
```

F. MODIFY:

```
Enter which modification option you want -
Change, Delete, Activate, Inactivate
```

1. Change

```
Enter Old Account: <0123456789>
```

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```
          Enter New Account: <9876543210>
           - Enter <CR> to terminate loop! -
          Enter Initials: <ABCD>
          User ABCD's account 0123456789 has been changed
          to 9876543210
           - Enter <CR> to terminate loop! -
          Enter Initials: <CR>
          Would you like to change another Account ? :
```

2. DELETE

```
          Enter ACCOUNT: <0123456789>
         · - Enter <CR> to terminate loop! -
          Enter INITIALS: <ABCD>
          Account 0123456789 has been successfully modified
          for ABCD
          Enter INITIALS: <CR>
          .. PAF entry 0123456789 successfully modified ...
          Would you like to delete another Account ? :
```

3. ACTIVATE

```
          Enter ACCOUNT:
           - Enter <CR> to terminate loop! -
          Enter INITIALS: <ABCD>
          Account 0123456789 has been successfully modified
          for ABCD
          Enter INITIALS: <CR>
          Would you like to CHANGE another ACCOUNT? :
```

4. INACTIVATE

```
          Enter ACCOUNT:
           - Enter <CR> to terminate loop! -
          Enter INITIALS: <ABCD>
          Account 0123456789 has been successfully modified
          for ABCD
          Enter INITIALS: <CR>
          Would you like to CHANGE another ACCOUNT? :
```

G. HELP:

H. STOP:

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2 LOGIN

A method needed to be developed to give users an
opportunity to charge to different job order numbers when
working on various projects simultaneously. 189 considered
assigning different accounts for each job order number that
the user wished to charge to, but decided to allow each
user to have only one VMS account, and to allow them to
charge to as many job order numbers as they required. The
scheme works as follows:

1. When a user is first authorized to the VMS system, (see
    UPDATE, section I,1.4 A; the ADD module), the Computer
    Center assigns the user a username. In addition, the
    CAS files, CAF, PAF, and UDF are updated to reflect the
    job order number(s), and default device to be
    associated with this account. When a user logs on to
    VMS, a local routine, CAS_SYLOGIN, intercepts after VMS
    has successfully 'logged in' the user, and determines
    if the user has been authorized for only one, or more
    than one job order number.

2. If the user is authorized for only one job order
    number, then a privileged routine, GETACCT, extracts
    the user's ten character job order number from the
    appropriate record in the CAF.

    a. GETACCT then packs the job order number into eight
        bytes and stores it in the VMS ACCOUNT field in the
        user's process data structures before returning
        control to CAS_SYLOGIN.COM.

    b. The Computer Center's INIT.COM procedure is
        executed to define symbols and logicals as an aid
        to the user.

    c. User's default directory is set

    d. LOGIN.COM residing in the user's default directory
        is executed.

3. If an interactive user has been authorized for more
    than one job order number, then CAS_SYLOGIN behaves
    differently. After detecting the multiple job order
    numbered user:

    a. INTERACTV, a privileged routine, prompts the user
        via the SYS$QIO VMS System Service, for the desired
        job order number.

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b. The user is given three attempts to enter a ten character code which matches one of those which are under that user in the CAF.

c. Prompts are timed so that the connection will be dropped if nothing is entered. The number entered by the user not only must be in the CAF, but also must be ACTIVE.

d. INTERACTV then packs the job order number into the VMS ACCOUNT field the same way GETACCT does.

e. Control then returned to CAS_SYLOGIN.COM for executing INIT.COM, setting the default directory, and executing the user's LOGIN.COM.

4. Batch jobs from users with more than one job order number are required to contain a job order number in columns 1-10 of the first record of the job.

a. A privileged routine BATCH, compares this job order number with the active job order numbers in the user's CAF record(s).

b. If the job order number is invalid, an informative message is written to the logfile, and the job is terminated.

c. If the job order number is valid, BATCH packs the job order number into the VMS ACCOUNT field like GETACCT and INTERACTV do it.

d. BATCH then returns control to CAS_SYLOGIN.COM for executing INIT.COM, setting the default directory, and executing the user's LOGIN.COM.

Thus far we have seen only one difference between CAS and standard VMS - a multiple job order number user is prompted for the job order number interactively, and must supply a job order number as the first record of a batch job. With these enhancements we have effectively solved the problem of the conversion between ten character job order numbers and the eight character VMS ACCOUNT field, and have also successfully accounted for users who need to work for multiple projects. However, we have left out one very important aspect - how does one charge for the filespace for a user with multiple job order numbers?

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A number of alternatives were considered. Even modifying
the VMS file header was considered, but rejected due to the
obvious vulnerablilties to VMS which would be made by such
a decision. The solution, though strange in appearance to
the users, is both functional and protective to the VMS
file system. 189 chose to treat the user's root directory
as VMS treates the Master File Directory (MFD). That is,
it is owned and controlled by the System; a user cannot
alter files directly below it. In addition, subdirectories
of the root directory are created which are treated like
VMS' root directories of the form, JONx.DIR;1 - where x is
the job order number to be charged for these files. One
JON directory is created for each JON the user is
authorized for. (see Fig. 2.1, 2.2) During the login
process the user automatically defaults to the JONx
subdirectory which corresponds to the job order number
being charged for that session.

Standard VMS

```
        DEVICE:[000000]     <---- MFD (Master File
            / ...  |  ... \              Directory)
           /       |       \
      [USER1]   [USER2]   [USERx]   Root Directory
         .         .        .       (User 'owns' files
         .         .        .                under here)
         .         .        .
```
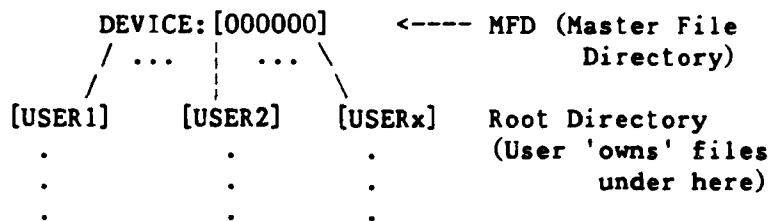
FIG. 2.1

CAS Implementation

```
        DEVICE:[000000]     <---- MFD (Master File
            / ...  |  ... \              Directory)
           /       |       \
      [USER1]   [USER2]   [USERz]   Root Directory
       /        / ... \      |      (Treated like VMS MFD)
      /        /       \     ---------
     /        /         \            |
[USER1.JONx] [USER2.JONx] [USER2.JONy]  |
     .          .          .         |
     .          .          .      [USERz.JONw]
     .          .          .
     .          .          . (User 'owns' files under here)
     .          .          . (Treated like VMS Root
     .          .          .                Directory)
```

FIG 2.2

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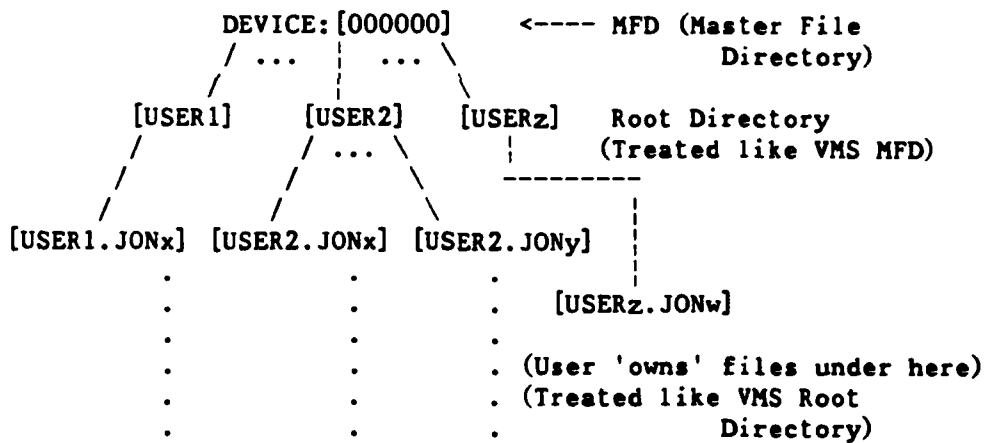
3 ADVANTAGES/DISADVANTAGES OF CAS VS. STANDARD VMS

1. ADVANTAGES

1. A user with one job order number sees no difference from standard VMS except for the longer path name to files.

2. A user with more than one job order number can share files between the job order numbers since they are the owner of all files in the root directory; thus serving as a group.

2. DISADVANTAGES

1. Longer path name to files

2. CAS files need to be maintained and carefully kept in synchronous with the VMS User Authorization File.

4   ANALYZE

NOTE

In this section the following convention will be
assumed:

Convention   Meaning
<DATE>   date of the form DD_MMM_YYYY
                    (previous day)

This section provides an overview of the way the analysis
for CAS is completed.   On each node in the VAXcluster,
shortly after midnight, DAILY_JOBS.COM is executed.   In
addition to its other tasks, DAILY_JOBS.COM controls the
accounting period by closing the accounting file   and
renaming the lowest version.   (An accounting period is
typically 24 hours, beginning and ending at 00:05. However,
the period from Saturday at 00:05 through Tuesday at 00:05
is defined as one accounting period.) DAILY_JOBS.COM also
executes GENACTDATA.COM which analyzes the VMS Accounting
File. GENACTDATA.COM completes two tasks; first it breaks
down the Accounting File into two files of the form
<DATE>_acctng_prime.dat and <DATE>_acctng_discnt.dat. Next,
it breaks down these two files into separate classes, BATCH,
DIALUP, and DIRECT CONNECT.   These files are named as
follows: DTx_SUMMy_<DATE>.DAT; where x is the node number,
and y indicates the contents of the accounting summary files
(see Fig. 3.1).

y	Contents of summary file
1	DIALUP - normal CPU
2	DIALUP - discount CPU
3	Dedicated Port - normal CPU
4	Dedicated Port - discount CPU
5	BATCH - normal CPU
6	BATCH - discount CPU

Fig. 3.1

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At twenty minutes past midnight, a time chosen to guarantee that the requisite accounting summary files have been created, the main routine in the analysis process, ANALYZE.COM is executed.

ANALYZE.COM is the routine which ties all of the accounting together across the VAXcluster. The operations of ANALYZE.COM follow:

1. Generates templates for an error file, <DATE>_ERRORS.DAT, and the Accounting Transfer File (ATF) <DATE>_CDCTEMP.DAT. These are both indexed files with the primary key being job order number, and the secondary key being username. The ATF is created by CDCTEMP.FDL, and the error file is created by ERROR.FDL. Both of these '.FDL' files contain a VMS File Definition Language (FDL) in order to call the VMS $ CREATE/FDL command to execute.

2. Calls FILESPACE.COM to determine the filespace used by each user for each authorized job order number. This is completed by sequentially reading from the CAF, appending the job order number to the user intials, (as the first level subdirectory), and forming the VMS $DIR-/SIZE=USED... command to determine the filespace used through that user's directory tree. Output goes to a temporary file <DATE>_BLOCKS.DAT. (If a device is sensed to be OFFLINE, this record is skipped, and the job continues. Later in the process, a record gets written to the error file to flag the problem).

3. Calls STOREBLOCKS.EXE to start populating the ATF, which holds the analyzed accounting output to be transferred to the Mass Store System (MSS) for Code 189.3 to access. (see Fig. 3.2)

    a. sequentially reads each record from <DATE>_BLOCKS.DAT

    b. applies storage charges to each record based on the current charging rates. (Stored in CHARGES.INC)

4. The ATF is now ready to be populated with the rest of the resource accounting information.

5. Logical names are assigned to each of the six created accounting summary files for each processor, in the form of FOROxy; where x is the node number, and y is the accounting summary file number (see Fig. 3.1).

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6. A foreign command symbol is defined for executing
    ANALYZE.EXE with the input parameter xy; where x and y
    are as discussed above. ANALYZE.EXE can determine, by
    this parameter, not only which rates to apply to the
    data, but also where to get the data. By converting the
    character string xy passed to ANALYZE.EXE, the
    appropriate logical name can be accessed to read the
    data.

7. ANALYZE.EXE is called once for each of the files
    associated with a logical name and is executed, at most,
    six times per processor. ANALYZE.EXE:

    a. determines which file to get the accounting summary
        data from

    b. sequentially reads each line of data from the
        summary file

    c. checks the Account number field to guarantee that it
        is decodable

    d. if not decodable, the record is skipped

    e. Account number is unpacked into the unique 10
        character job order number

    f. CPU and Connect Time resources are broken down into
        seconds by GETSECNDS.EXE

    g. charges are applied to all accountable resources.
        (CPU, Connect Time, Pages printed, Volumes mounted)

    h. performs keyed read on the ATF, by using job order
        number and username to locate the appropriate record

    i. if the record is not located, a record gets written
        to the error file

    j. located record gets updated by adding resource and
        resource charge information from the accounting
        summary file to the current values of these fields
        in the ATF.

8. Note that if an accounting summary file is determined to
    be empty, ANALYZE.EXE is not called for that file.

9. CDCDUMP.EXE is called to convert the indexed file, ATF,
    to a sequential file.

10. CDCLIST.EXE is called to generate a printable listing of the transfer file on VMS. (This is for comparison purposes, to guarantee that the ATF is transferred accurately).

11. Provides a method of automatically sending the ATF across to the MSS using MUX200, (a 200UT protocol emulator between VMS and NOS/BE on CDC machines), to one of the NOS/BE CDC CYBER machines, and then onto the MSS. GENMUXJOB.COM:

    a. creates the batch job MUXLOAD.COM, and submits it to run at five minutes past seven on Monday through Friday. (For holidays and other times when the CYBER machines may be down, a file HOLIDAY_SUBMIT.TIME is scanned for an alternate time to $SUBMIT MUXLOAD.COM)

    b. MUXLOAD.COM contains all of the necessary VMS, $MUX, and NOS/BE commands to effect the transfer from the VAXcluster, through the CYBER machines, and then onto the MSS.

12. Sends listings of the CAF, PAF, RIGHTSLIST.DAT, and the UAF to the printer.

13. Purges any summary files which are older than twenty days.

14. EXITS.

Though it may appear to be a bit cumbersome to include so many calls to ANALYZE.EXE, it was determined to be the most appropriate option since nodes may be added to the Cluster, or taken away, without major modification to the analysis scheme. In addition, if other resource charging schemes are eventually implemented, such as the addition of dedicated lines which generate a surcharge in Connect Time rates, only minor changes would have to be made.

Note that the whole analysis process is completed automatically without any human intervention. ANALYZE.COM resubmits itself daily in order to complete its task, and is programmed to resubmit itself and exit on Sunday and Monday mornings before doing any work, since the accounting period is not closed.

Format of the Accounting Transfer File (ATF)

Position   1-10   Job Order Number (primary key)
Position 11-14   User Initials   (secondary key)
Position 15-21   Connect Time (hours)
Position 22-29   Connect Time Charge
Position 30-39   CPU Time (seconds)
Position 40-47   CPU Time Charge
Position 48-52   Number of Pages Printed
Position 53-59   Print Charge
Position 60-61   Number of Tape Mounts
Position 62-67   Number of blocks of Disk space
Position 68-75   File charge based upon 30 days
Position   76   Job Order Number Flag
Position   77   User Flag

FIG 3.2

5   FUTURE ENHANCEMENTS

The following section includes some enhancements planned for
the future.

    I.   UPDATE
          B.   LIST
               - provide more varieties of listings

          F.   MODIFY
               a.) CHANGE
                   - this module needs to be enhanced
                   - currently, some UAF modification needs to
                   be completed manually

               b.) DELETE
                   - this module needs to be enhanced
                   - currently, some UAF modification needs to
                   be completed manually

          G. HELP
              - some online HELP needs to be developed.

    III. ANALYZE
          A more reliable means of transferring the ATF for
          189.3 will be implemented once the HYPERchannel
          link is installed between the VAX Systems and the
          CDC machines.

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